on the botanical discoveries of M. Roezl in America, and two fine coloured plates of *Cypripedium Spicerianum*, and *Aphelandra Margaritæ*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 19.—"The Influence of Stress and Strain on the Physical Properties of Matter."[1] Part I. Moduli of Elasticity—*continued*. Relations between Moduli of Elasticity, Thermal Capacity, and other Physical Constants. By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

The thermal capacity of each of the wires already used for the experiments on moduli of elasticity and electrical conductivity described in Parts I. and II. of this paper[2] was determined.

Every precaution was taken both with regard to the instruments themselves and the mode of using them to avoid error, and the formulæ given below may be received with great confidence.

Metal	Density at 20°C., density of water at 4° C. = 1	Formulæ for the number of thermal units required to raise the temperature of unit mass from 0° C. to t° C. Thermal capacity of water at 0° C. = 1.	Thermal capacity per unit mass at t° C.
Aluminium ...	2·731	$\cdot20700t + \cdot00011152t^2$	$\cdot20700 + \cdot0002304t$
Iron	7·759	$\cdot10601t + \cdot00007017t^2$	$\cdot10601 + \cdot0001402t$
German-silver.	8·632	$\cdot09411t + \cdot00000053t^2$	$\cdot09411 + \cdot0000106t$
Zinc	7·138	$\cdot09009t + \cdot00003743t^2$	$\cdot09009 + \cdot0000748t$
Copper	8·851	$\cdot09008t + \cdot00003241t^2$	$\cdot09008 + \cdot0000648t$
Silver	10·464	$\cdot05466t + \cdot00002181t^2$	$\cdot05466 + \cdot0000436t$
Tin	7·264	$\cdot05231t + \cdot00003611t^2$	$\cdot05231 + \cdot0000722t$
Platinum-silver	12·616	$\cdot04726t + \cdot00001381t^2$	$\cdot04726 + \cdot0000276t$
Platinum ...	21·309	$\cdot03198t + \cdot00000631t^2$	$\cdot03198 + \cdot0000125t$
Lead	11·193	$\cdot02993t + \cdot00001531t^2$	$\cdot02998 + \cdot0000306t$

It will be seen that the thermal capacity of all the metals examined increased with the temperature, a result which we find confirmed by the observations of other investigators.

The thermal capacities of the alloys platinum-silver and German-silver are, within the limits of error, exactly the same as those calculated from the proportions of their components. Thermal capacity is, therefore, a physical property which is not likely to be altered to any appreciable extent by small impurities, so that the results obtained by different experimenters agree very closely with each other.

It has been proved[3] that if e be taken to denote "Young's Modulus," and α the mean distance between the centres of two adjacent molecules, $e \times \alpha^7$ is in the case of most metals approximately a constant. From this it would follow that the law of force proved by Maxwell in his experiments on the viscosity of gases[4] to exist between the molecules of a gas is approximately true for solids, accordingly the force between any two adjacent molecules of a solid is approximately as the fifth power of the distance between their centres. Now if we denote the atomic mass by A, the density by Δ, the thermal capacity per unit mass by C_m, and the thermal capacity per unit volume by C_v, we have the following relations:—

$$C_m \times A = \text{a constant};$$
$$C_v = \Delta \times C_m;$$
$$e \times \alpha^7 = \text{a constant};$$
$$\alpha \propto \left(\frac{A}{\Delta}\right)^{\frac{1}{3}}$$

From these relations we obtain—

$$\frac{e}{C_v^{\frac{7}{3}}} = \text{a constant};$$

or that the cube of "Young's Modulus" varies as the seventh power of the thermal capacity per unit volume. This relation was found to hold approximately not merely for the metals here examined, but also in the case of a great many substances for which the values of C_v and e have been determined by other investigators.

Still more approximately is it believed that this relation would hold good if for "Young's Modulus" the bulk-modulus of elasticity were substituted. Denoting the bulk-modulus by e_v, it was found that, within the wide limits of error to which determinations of the value of the bulk-modulus are liable to be affected—

$$\frac{e_v}{C_v^{\frac{5}{3}}} = \text{a constant}.$$

Neither of the above relations can be true for all temperatures, inasmuch as, whilst the value of e_v diminishes with rise of temperature, that of C_v increases, but at ordinary temperatures it seems that the bulk-modulus of elasticity can be calculated from the thermal capacity per unit volume by the formula—

$$e_v = 2071 \times 10^6 C_v^{\frac{5}{3}}.$$

The thermal capacity per unit volume increases with the temperature, and the researches of Matthiessen, Fizeau, and others on the one hand, and of Kohlrausch on the other, have shown that there is a like increment in the thermal expansibility and torsionability[1] of metals. A careful comparison was made of the various increments above mentioned, and it is shown in the paper that whilst the ratio of increase per unit of expansibility with rise of temperature to corresponding value in the case of torsionability[2] is, within the limits of error of observation, unity, that in which thermal expansibility and thermal capacity are concerned is about two, so that the rate at which thermal expansibility increases with the temperature is about twice the rate at which thermal capacity increases. The rate of increase of both thermal expansibility and thermal capacity varies with the nature of the metal, being greatest for iron and least for platinum.

The so-called "real thermal capacity" of a solid may be found by dividing the thermal capacity of hydrogen per unit mass at constant volume, namely, 2·417, by the atomic mass; and this part of the capacity will be independent of the temperature. If the "real capacity" be subtracted from the total thermal capacity we obtain that part of the capacity which does vary with the temperature, and which has therefore in this paper been designated the "variable thermal capacity." The following table shows that *the rate of increase per unit of thermal expansibility is at 0° C., and therefore at any temperature, equal to the increase per unit of the "variable capacity"*:—

Metal	Rate of increase per unit at 0° C. of "variable thermal capacity" = C′	Rate of increase per unit at 0° C. of thermal expansibility = E	$\frac{E}{C'}$
Iron	·00230	·00309	1·34
Tin	·00216	·00250	1·16
Aluminium	·00197	·00215	1·09
Lead...	·00192	·00174	0·91
Copper	·00127	·00196	1·54
Zinc	·00157	·00170	1·09
Silver	·00135	·00155	1·15
Platinum	·00064	·00061	0·95

It is shown in the paper that the thermal capacity per unit mass is nearly two and a half times the "real capacity," so that only two-fifths of the whole thermal energy which we may impart to a mass of metal goes towards raising the temperature, the remaining three-fifths being expended in internal and external work. The external work is practically insensible in ordinary cases. Of the internal work, that expended against bulk-elasticity amounts in the limiting cases from 1/1,000th to 1/10,000th of the whole, and, though greater than the external work, is almost insensible; moreover, there seems to be no relationship whatever between the whole thermal capacity per unit volume and the work done against bulk-elasticity.

Raoul Pictet has concluded[3] that the amplitude of the oscillation of molecules around their positions of equilibrium may be taken as corresponding to temperature, and in the case of several metals has shown that

$$T \times \beta \times \alpha = \text{a constant},$$

[1] The original title of the paper has been altered to the above, as being more exact in expression.
[2] *Phil. Trans.* part i., 1883, p. 1.
[3] *Loc. cit.* p. 32.
[4] *Phil. Trans.* 1866, vol. cxxvi. part i.

[1] The inverse of "simple rigidity."
[2] Iron and copper are the only two metals for which the increase of torsionability with rise of temperature has been examined.
[3] NATURE, 1879, p. 356.

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where T is the melting-point temperature reckoned from absolute zero, β the coefficient of linear expansion, and α proportional to the distance between the centres of adjacent molecules. From the above relation, combined with those already mentioned, we deduce

$$\frac{T \times \beta}{C_v^{\frac{1}{3}}} = \text{a constant};$$

and

$$\frac{T \times \beta}{e_v^{\frac{1}{3}}} = \text{a constant.}$$

The first of these two relations was found to hold good for ten out of twelve metals examined, but for the metals bismuth and antimony the ratio $T\beta : C_v^{\frac{1}{3}}$ is almost exactly *one-half* of the ratio obtained for the other metals. It was concluded that for most metals the melting-point temperature may be approximately calculated from the formula—

$$T = \cdot 02253 \times \frac{C_v^{\frac{1}{3}}}{\beta}.$$

Where C_v and β represent the mean thermal capacity per unit volume, and coefficient of expansion respectively between 0° C. and 100° C.

The second of the two relations was found also to approximately hold good.

In the paper will be found a full discussion of the experiments of Joule[1] and Edlund[2] on the thermal effects produced by mechanical stress in metals.

According to the researches of the latter the *observed* thermal effects of longitudinal stress on a wire is to be found by dividing the *theoretical* thermal effects by 1·61, since part of the work expended on a wire which is stressed longitudinally finds its equivalent in molecular effects which are not thermal. This view seems to be partly supported by some experiments made by the author on the viscosity of metals.

Zoological Society, June 17.—Prof. W. H. Flower, President, in the chair.—Mr. H. Seebohm exhibited and made remarks on some specimens of rare Asiatic and European birds, and called special attention to examples of a newly-discovered Russian species, *Bonasa griseiventris* (Menzbier).—Mr. Sclater exhibited the knob of the culmen of the beak of a Rough-billed Pelican (*Pelecanus*), which had been shed by the bird in the Society's Gardens last autumn; and called attention to the fact that on coming into breeding plumage again this summer the bird had grown another knob.—Mr. Sclater also called the attention of the meeting to a very singular habit of a Vasa Parrot (*Coracopsis vasa*), as observed in the Society's Gardens.—Mr. F. Holmwood gave an account of his observations on the employment of the *Remora* by native fishermen of Zanzibar for the purpose of catching turtle and large fishes.—Mr. R. Bowdler Sharpe read some further notes on the new Corsican Nuthatch (*Sitta whiteheadi*), in continuation of former communications on the same subject.—A communication was read from Dr. G. Hartlaub, in which he gave the description of a new species of Creeper of the genus *Salpornis*, discovered in Eastern Equatorial Africa by Dr. Emin Bey. The author proposed to name it (after its discoverer) *Salpornis emini*.—Prof. Flower, F.R.S., read a note on the names of two genera of Delphinidæ, which he found it necessary to change.—A communication was read from Dr. Camerano, giving a summary of the distribution of the native Batrachians in Italy.—Mr. G. A. Boulenger gave the description of a new variety of lizard of the genus *Lacerta* from South Portugal, which he proposed to describe as *Lacerta viridis*, var. *gadovii*.—A communication was read from Mr. H. O. Forbes, containing remarks on a paper by Dr. A. B. Meyer on a collection of birds from the East-Indian Archipelago, with special reference to those described by him from the Timor-Laut group of islands.—Lieut.-Col. C. Swinhoe read a paper on some new and little-known species of butterflies of the genus *Teracolus*. The author referred to and described twenty-two species, sixteen of which were new to science, and the others very rare.—A communication was read from Mr. Francis Day, F.Z.S., on the occurrence of *Lumpenus lumpetriformis* off the east coast of Scotland.—Mr. Oldfield Thomas read a paper upon the Muridæ collected by M. Constantin Jelski, near Junin, in Central Peru, during the years 1870-73. The collection consisted of ninety-two specimens, representing twelve species, mostly belonging to the genus *Hesperomys*, the nine sub-genera of which were now arranged and re-defined. One species and two varieties were described as new under the names of *Rheithrodon pictus*, *Hesperomys laticeps* var. *nitidus*, and *H. bimaculatus* var. *lepidus*.—A communication was read from Mr. W. E. Distant describing the Rynchota collected by the late Mr. W. A. Forbes on the Lower Niger. The collection contained examples of twelve species, eleven of which belonged to the Hemiptera and one to the Homoptera. Two species appeared to be undescribed.—Prof. Mivart, F.R.S., read a paper on the development of the individual and of the species as forms of instinctive action.—This meeting closes the present Session. The next Session (1884-1885) will commence in November next.

Geological Society, June 11.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Charles Edward Bainbridge, John J. Evans, William Frederick Fremersdorff, and Henry de Morgan Snell, were elected Fellows of the Society.—The following communications were read:—The range of the Palæozoic rocks beneath Northampton, by Henry John Eunson, F.G.S.—On some Zaphrentoid corals from British Devonian beds, by A. Champernowne, M.A., F.G.S.—On the internal structure of *Micrabacia coronula*, Goldf., sp., and its classificatory position, by Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., F.G.S.

Anthropological Institute, June 10.—Prof. Flower, F.R.S., president, in the chair.—A paper was read on the deme and the horde by A. W. Howitt, F.G.S., and the Rev. Lorimer Fison, M.A., in which the authors traced a close resemblance between the social structure of the Attic tribes and that of the Australian aborigines. The word horde is used to indicate a certain geographical section of an Australian community which occupies certain definite hunting-grounds. Its members are of different totems; in fact all the totems of the community may be represented in any given horde. Descent being through the mother as the general rule, the child is of its mother's totem, not of its father's, but it belongs to the horde in which it was born. So, too, the children of aliens are admitted into the exclusive organisation by virtue of a right derived from their mothers. In Attica there were also two great organisations—one based originally on locality, and another whose sole qualification was that of birth—the demotic and phratriac. Both included the free-born citizens, and therefore coincided in the aggregate, but no deme coincided with any phratria, or with any subdivision of a phratria. The naturalised alien was enrolled in one of the demes, but there could be no admission for him into a phratria; if, however, he married a free-born woman his children by her were not excluded, they were enrolled in her father's phratria, the relationship between a child and its maternal grandfather being looked upon as a very near tie of blood. Thus, making all necessary allowance for difference of culture in the two peoples, it appears that the phratriac is analogous to the social organisation in Australia, while the demotic divisions correspond to the Australian hordes.—A paper by the Rev. C. A. Gollmer, on African symbolic language, was read, in which the author described the method by which the natives of the Yoruba country send messages to one another, and communicate their wishes by a variety of tangible objects, such as shells, feathers, pepper, stones, coal, sticks, &c.

EDINBURGH

Royal Society, June 16.—Dr. Saug, Vice-President, in the chair.—The Astronomer-Royal for Scotland communicated a paper on micrometrical measures of gaseous spectra, which was accompanied by several elaborate maps of the spectra examined. The instrument used gave a dispersion of 1200 degrees. Among several curious results indicated was the fact that the spectrum of nitrogen indicates it to be a compound, while oxygen and hydrogen act as if simple substances. Prof. Smyth also gives the spectra of carbon-oxygen and carbon-hydrogen compounds.—Dr. Saug read a paper on the computation of recurring functions, by the aid of chain-fractions.—Prof. Tait communicated a note by A. H. Auglin on an extension of Euclid I. 47. Mr. Auglin showed how, by regarding equiangular and equilateral polygons described on the sides of a right-angled triangle as being composed of equal isoccles triangles the methods of Euclid's First Book might be used to prove the 47th Proposition as extended to equiangular and equilateral polygons.—W. E. Hoyle gave a paper on the Ophiuroidea of the Faroe Channel.

PARIS

Academy of Sciences, June 23.—M. Rolland, President, in the chair.—Researches on the origin and transformations of the

[1] *Phil. Trans.* 1859, vol. cxlix. p. 91.
[2] *Ann. der Phys. und Chemie*, Band cxxvi. p. 539.

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nitrates universally present in the vegetable kingdom, by M. Berthelot. From his experiments the author infers that the nitrates, derived partly from the soil, partly from the atmosphere, are found chiefly in the stems of plants, varying from almost infinitesimal quantities to 15 thousandths in the potato, 28 thousandths in wheat, and even 150 thousandths in certain species of Amaranthus.—Report on the documents, published by the Minister of Public Works, connected with the mission undertaken by Lieut.-Col. Flatters to the region south of Algeria, by M. Daubrée. The object of this mission, carried out in the winter of 1880–81, was to ascertain the possibility of constructing a railway across the Sahara, between the French possessions on the Mediterranean and the Atlantic. As far as the Asiu wells, the extreme point so far reached, no serious obstacle was met, and for over 350 miles to the south of Wargla, the ground was found to be so easy that a line might be constructed to this point at an outlay of about 4000*l.* per mile.—Arithmetical commentary on a formula of Gauss (continued), by M. de Jonquières.—Report of the Suez Canal International Committee, meetings of June 16 and 19, communicated by M. de Lesseps. The Committee pronounces in favour of simply widening the Canal in preference to constructing another.—Election of Dr. Salmon as Corresponding Member for the Section of Geometry in place of the late Mr. Spottiswoode.—Report on two cases of secondary suture of the central nerve attended by rapid restoration of the functions of the nerve in the paralysed parts, by M. Tillaux.—Remarks on some phenomena of chemical occlusion: occlusion of one gas by another, by M. P. Schutzenberger.—On a new method of synthesis of nitrous organic compounds; complete synthesis of xanthine and methylxanthine, by M. Arm. Gautier.—Researches on the formation and structure of the gray embryonic substance in the spinal marrow of the higher vertebrate animals, by M. W. Vignal.—Description of the Calocoris, an insect of the genus Phytocoris, which infests the vine and young grape, by M. G. Patrigeon.—Note on a generalisation of the theory of reduced quantities, by M. Em. Barbier.—Remarks on the height and annular form of the mountains on the planet Venus, by M. P. Lamey. From a careful study of a series of designs of the planet executed at Grignon during the present year, the author infers that a perfectly circular protuberance in the southern hemisphere, presumably a volcano, has an elevation of probably not less than seventy miles. He argues that this enormous height is in no way incompatible with the volcanic nature of the planet.—Description of a new mercurial electro-dynamometer, by M. G. Lippmann.—A study of the spheroidal state of fluids and their freezing-point under pressure, by M. J. Luvini.—Note on the glyoxalbisulphites of potassa and baryta, by M. de Forcrand.—Researches on ferricopotassic tartrate, ferric arseniate, arsenite of iron, and other colloidal sulphates of iron, by M. E. Grimaux.—A comparative study of the alcohols derived from the xylenic carburets, by M. A. Colson.—Remarks on the natural saltpetres of Chili and Peru, in connection with rubidium, cæsium, lithium, and boric acid; practical application to the beet-growing districts in the North of France, by M. Dieulafait.—Distribution of the saline substances of the grist in the various products of the corn-mill, by M. Balland.—Note on the poison of the Hymenoptera, and anatomical description of their secreting organs, by M. G. Carlet. The author concludes that the poison of these insects is always acid; that it is composed of two distinct liquids, one extremely acid, the other slightly alkaline; and that these two liquids are secreted by two special glands, the *acid* and the *alkaline* glands, which discharge their contents at the base of the gorgeret, or sheath of the sting.—On a new type of elastic fibre observed in the larva of Eristalis, by M. H. Viallanes.—On the development of the digestive tube of the Limaceæ, by M. S. Jourdain.—Note on the Geological Map of France, scale 1 : 500,000, prepared by MM. G. Vasseur and L. Carez. This map, the first executed since 1842, will be completed in forty-eight sheets early next year. Several of the sheets have already gone to press.

BERLIN

Physiological Society, May 30.—Dr. Falk has, in the course of an investigation of the phenomena of death by drowning, determined experimentally certain relations of the cutaneous nerves to respiration for which he claims a manifold practical importance. When rabbits are suddenly plunged into cold water of about 5°–7° C. a cramp of the expiratory muscles occurs, and respiration ceases in the position of expiration. This effect of cutaneous stimulation occurs even when the superior laryngeal nerves have been cut through. The recognised relation of the trigeminus to expiration, which manifests itself in the occurrence of sneezing upon stimulation of the nasal mucous membrane, was also confirmed in these experiments; when the face only was dipped into the cold water the expiratory cramp was very violent, whereas the sudden immersion of the hinder extremities and of the lower part of the body was inoperative, the effect not being produced till the breast and the neck were stimulated. The respiratory track of the larynx was the only part of it that was affected, when the face was not immersed, but the glottis closed completely when the trigeminus was stimulated. When the cutaneous nerves were more powerfully stimulated so that pain occurred, a violent inspiration set in. The methods of restoring persons apparently dead and still-born children to life have, according to Dr. Falk, no relation to the effect of cutaneous stimulation upon respiration; the dashing of cold water upon the chest acts upon the heart alone, and the pouring of water on the nape of the neck and back of the head acts upon the medulla oblongata.—Dr. A. Baginski, who had previously discovered the occurrence of xanthine bodies in the urine of children who were affected with nephritis, has followed up the occurrence of these substances, and has determined, by comparative examination of healthy and sick children, that xanthine occurs only in nephritis; and that the quantity of it present increases proportionately with the malignity of the attack. The circumstance that methyl xanthine resembles theobromine in its chemical composition suggested an examination of the tea, in which considerable quantities of guanine, xanthine, and hypoxanthine were detected. In the pancreas when putrefying the amount of xanthine substances were diminished, and of these guanine was the one of which, proportionally, most was destroyed by putrefaction. Next came xanthine, and hypoxanthine had the greatest powers of resisting putrefaction. The presumption that hypoxanthine would not even be destroyed by digestion was not borne out. After exhibition of hypoxanthine the quantity that occurred in the urine was not above the normal but rather a little below it. Its effect upon the heart was a very remarkable one, it occasioned much more active and energetic contractions, so that hypoxanthine may be regarded as a body which has the power of increasing the cardiac activity, and perhaps it is to this that the beneficial effect of tea-drinking may be attributed. Dr. Baginski intends to follow up the investigation of these interesting substances further.

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